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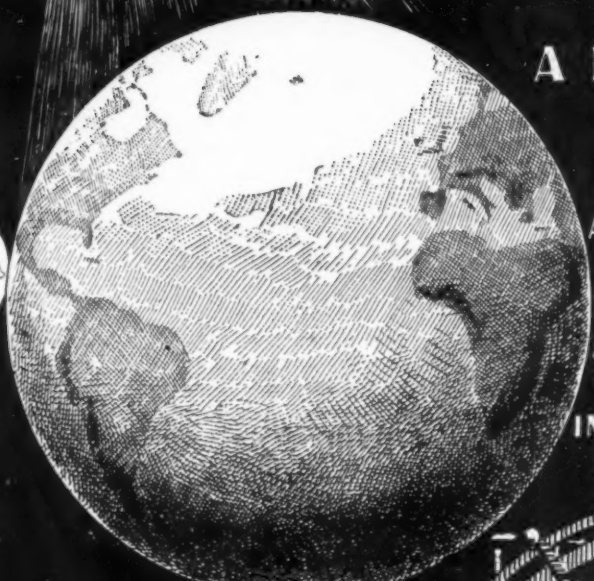
THE AMERICAN X-RAY JOURNAL



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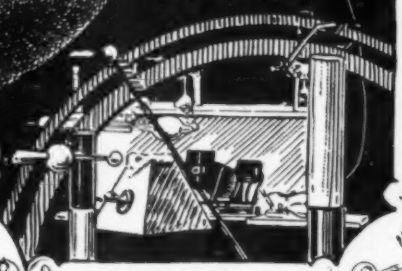

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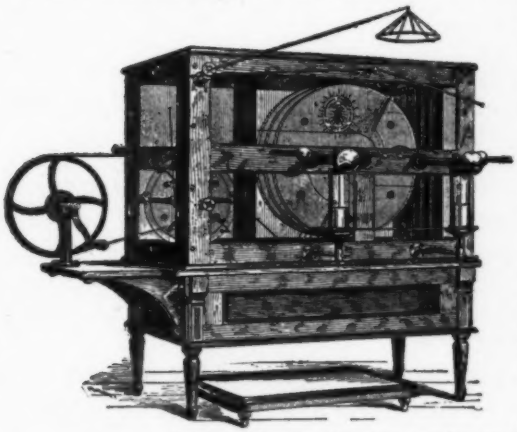

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CROOKES tubes or tubes containing only the "fourth state of matter", as described by Crookes, is attracting more attention now than at any previous time. The generating apparatus of an x-ray machine is improved to a most satisfactory degree. This is the case with both the coil and static machines. It is equally true that the discharge tube is brought up to a high state of development and probably to a greater efficiency than the generating apparatus, but the bugbear of high vacuum has retarded progress and kept the x-ray operator from getting out of his tube the service it should have rendered him. It now appears that instead of a tube losing its efficiency from use it actually gains in penetrating power the longer it is used in the proper manner. Heating or resting the tube are simply temporary expedients; re-exhaustion is a method to moderately renew the tube and in no way improves its former condition, but rather diminishes its former penetration and endurance.

Dr. Wm. W. Graves, of this city, has shown in his most excellent article "A Preliminary Report on a Method of Overcoming High Resistance in Crookes Tubes; A Possible Step Towards Maximum Radiance," published in the April issue of THE AMERICAN X-RAY JOURNAL, "that the greater the resistance as afforded by the vacuum tube the higher will be its efficiency when the resistance is overcome." If resistance is wholly determined by the vacuum within the Crookes tube then the vacuum can be changed a dozen times in a minute—lowered and raised at will. It does not seem possible that so great egress and ingress of the elements of air could take place through the glass at one time, without displaying rapid modification in the vacuum at all other times when intense discharges are passed through the tubes. Constancy is the ideal condition and is observed when the full output of a machine is passing through a tube which silently glows, noiselessly as an incandescent lamp. It is thinkable that the elements or ions within the tube are disarranged by electrical discharges in such a way as to diminish the x-ray out-

put. Proper manipulation of the tube rearranges and adjusts the elements in such a way that former efficiency returns and even greater penetrating power is obtained. The accomplishment of a method for obtaining greater radiance is fully set forth in Dr. Graves' article. It has been my pleasure and fortune to witness the doctor develope a tube that had been "worked out" and abandoned as worthless, to a state of producing x-rays superior to its former penetration. With such tubes of great resistance, capable of backing up a spark of ten inches reversed, very powerful x-radiance is engendered. A good tube recently from the maker showed the heart in a large man ten feet distant through a closed door. A tube which formerly produced equally as good radiance as this one, but in which the resistance from usage was too great under all ordinary methods to obtain a responsive glow, was by the Graves' method of reducing resistance, worked up to a state of excellence capable of showing the heart distinctly through a closed door 16 feet distant from the tube. Through the upper third of the forearm the bones of the hand could be seen 28 feet from the tube—the wall of the room limiting a more distant test.

Such penetrating radiance as the above engendered in a tube that had been considered worthless or exhausted from long usage claims our admiration and inspires us to inquire for an explanation of the internal changes which take place in a tube in action. For this particular knowledge we instinctively turn to Tesla, Thomson, Roentgen or other physicists.

We are now concerned with a method for getting the best and most enduring radiance from an x-ray tube. If the claims of Doctor Graves are correct, x-ray tubes can be used for an indefinite time with ever increasing value. Dr. Monell, of Brooklyn, has used one tube for one year without any impairment in its usefulness.

With such tubes and with a proper generating apparatus every part of the interior of the body can be explored. There is no distortion of shadow in the sense of casting a deceptive image; time is not considered since the denser tissues as the head of the femur are instantly seen in very large subjects; and there should never be such a thing as burns since the electrical discharge is confined in close proximity to the tube, probably at no greater distance than 15 inches. The fright that has gone out and been accepted by some as true, of "x-ray burns" should be stilled. The scare has a tendency to retard progress and the medical profession are not warranted, neither is it their wont, to spread false information. The use of the word x-ray to the word burn is a misapplication of the term and conveys a false impression. No one has ever demonstrated that the x-rays burn. Effort has been made to destroy animal tissue with the x-rays with failure in every instance. Dr. Carl Beck made an exposure of four hours without any ill effect and this has been repeated in a number of instances in Europe and America with like results. In the neighborhood of the tube and in the field of the wasting electric discharge injuries will occur and they will occur also if exposed for a considerable time anywhere along and near to the conducting wires. "Potential injury" would more nearly express the meaning.

"Whether for fluoroscopic or cathodographic work, approaching maximum radiance is always to be desired. A tube which gives only fair radiance has little practical value other than from development it may attain high efficiency."—Graves. This is true. Every operator with efficient generating apparatus has been able to demonstrate this fact. A deeper shadow and denser, it is true, is

seen when the highest generation of x-rays is not attained, but the detail is less and the relation of parts obscured. The observer standing in a valley and seeing animals on the crest of mountain spurs at dawn of day, is always impressed with the size and distorted prominence of the figures as they seem to lay against a lighted screen. The rising sun with greater light fades away the distortion and makes a true picture of what was seen, and so it is in the fluoroscope. When shadows are seen as if set in the screen they are very dense and prominent, but are void of detail and can be of but little value to the diagnostician. These are the conditions for distortions because varying conditions of density in the subject cast shadows which may be mistaken for fragments of bone or foreign matter. A bright screen with abundant x-radiance will throw the picture out and offers a perspective as if projected from the background. The detail is very apparent in contrast with the former picture.

The tube should have a constant glow. If the radiance is fluctuating and not constant examinations can not be satisfactorily made. The rising and falling of penetrating rays cast movable clouds across the screen and in a degree, change the aspect of the subject under examination into a doubtful diagnosis. A tube that is irregular in its action or flickers should not be cast aside. It is now in condition for the operator to acquire knowledge of technique in tube manipulation. With labor and perseverance the difficulty will probably be mastered. When we compare the advantages of the x-rays with other adjuncts to practice we find the former to be less difficult to acquire and always accurate in results. If results are obtained which are inaccurate it is because the operator has neglected his part, provided always that the tube and generating apparatus is up to the standard.

When it is desirable to make radiographs the same rule should obtain as in fluoroscopic examinations. The best possible light will in all cases make the best possible picture. Detail in the picture will be good only along the line of superior radiance. With the best light, skin, fat, muscles, bone, cancellated tissue and marrow are seen interposed one above the other. In some instances the tendinous tissue is plainly shown and the larger veins and arteries are very distinct. The art is rapidly approaching a condition for the separation of all the human tissues in one picture. The excellence of this work depends upon improved method of tube manipulation. When this has been acquired we can then ask for still better generating apparatus and better fluorescent material for the screen.

At the fourth annual meeting of the American Academy of Railway Surgeons at Chicago, Ills., Dr. W. J. Mayo, of Rochester, Minn., read a most instructive paper on "The Pathology and Diagnosis of Oblique Fractures" in which he refers to the use of the x-rays as a diagnostic expedient in the following language:

"At this time we are in the midst of a most splendid advance in the diagnosis of fractures, due to the impetus given by the x-ray, and to the wider scope of the diagnostic incision which modern wound treatment has made possible.

"The Roentgen rays, as an aid to the diagnosis of fractures, is one of the marvels of the day and the ability by this means to accurately map out fracture without removing the dressing has revolutionized the diagnosis. So common is its use that almost every issue of our periodicals contain skiagrams of bone traumatism. It is a matter of regret that only in the large hospitals or cities can it be utilized and unfortunately its revelation at a late date are apt to

prejudice a jury in the possible malpractice suit. In the very excellent skiagraphic work of Dr. Cross, of this city, I have noticed that the ultimate result is often good even when the bones are not accurately in place.

"Leonard Freeman in the 'Annals of Surgery' for April, 1897, says in this connection: 'It must often be true that when we imagine we have placed the fragment of broken bone in perfect apposition they may not be so after all, and yet the result be good, nature being capable of soothing off many inequalities.'

"Until we can better estimate nature's capacity for repair the skiagraph may cause much needless anxiety, and still more unfortunately for our peace of mind, show us errors in position which the condition of soft parts will not allow us to safely correct, or the process of repair may in the occasional case develop rather than prevent deformity. The x-ray may be made to exaggerate the existing deformity or displacement, from carelessness or purposely, and in suits for damage, no skiagraphs should be accepted unless made by a disinterested operator."

In the discussion which followed, the x-rays were referred to as follows:

Dr. J. P. Lord, of Omaha—While I believe that different skiagraphs of the same case will show very differently, yet I do not know that we can set them down as being inaccurate. I think it does show us that the conditions are exaggerated, and that the x-ray will teach us that there is a possibility for a great deal of deviation of bone fragments, although it must be admitted that it gives us a better idea than we ever had before of the extensive separation of the fragments, and this is the point that I wish to make, that we should collect a number of skiagraphs, as we soon will be able to do if we make comparatively general use of the instrument, which we all should do, and with the cheapening of the apparatus it will be within the means of those who practice to any considerable degree, and then we will have something to fortify us against x-ray pictures which might prejudice a jury. We might bring skiagraphs to show that a certain condition was common, and even though there is not a great deal of deformity, a great deal of callus and deviation of the fragments, yet comparatively good results followed treatment, and that this need not necessarily influence the result unfavorably. If the skiagraph influences the result unfavorably it is only what is to be expected, and the good results that are gained, perhaps in an individual case under dispute, are as favorable as could be expected under the circumstances. I believe that we are unnecessarily alarmed about the damage the x-ray may do us, and when we consider the strong advantages it has for us we will make the proper use of this sort of evidence. We may use it as a boomerang to counteract the influence which possibly may be used against us. We should consider this and use the x-ray with that end in view.

Dr. Fred. J. Hodges of Anderson, Ind.—Since the discussion has tended toward the consideration of the skiagraphic phase of the subject it is important to know that existing fractures do not always show and that there are undoubted cases on record in which the radiograph seems to show a fracture when it does not exist. These are two points of extreme importance. It is also important to know that a slight deviation in the angle of the bone to the plate will make a difference and a distortion of the resulting skiagraph. It has occurred to me that the only logical and legal way of bringing this matter before a jury would be to bring the apparatus into court and show the condition of the case with either the fluoroscope direct or with the screen. Not long ago I exam-

ined a radius, in which there was no doubt, from an ordinary physical examtion, as to the existence of a fracture, and yet it took half an hour with the fluoroscope to find it, and authenticated radiographs of that case, taken in half a dozen different positions, would have failed to show the fracture, so that a great deal of refinement in operating these pictures is necessary, as well as a great deal of certainty in the identification of them, and a description of the relative position from which they were taken, is going to be necessary in courts of law before the whole truth is brought out about these cases. *It is a well-known fact that impacted fractures do not show by the x-ray process, and it is also well known that in perfectly united fractures the new bone is not opaque to these rays, so that in perfect union there is still the appearance of non-union. Those are matters which particularly affect oblique fractures.

DR. W. L. SMITH, of Streator.—In regard to the x-ray I will say that it depends very much on the distance of the tube from the fracture what picture you get; also how fine you may cut the lines with the tube. I believe that if you have a funnel made of lead and allow the tube to sit on the top, then you can define very clearly the parts that are shown underneath. It does not take any longer with a funnel made of lead, which the x-ray will not penetrate at all, and you have nothing on the outside showing. So if you have a funnel about six inches high, and eight inches around, it will show very clearly what you desire to see. I believe the surgeon is the only man to place the limb so as to show what he wants to see. If a bullet is on top of a bone it will not show; if it is in the bone it will not show; if it is on the side it will show and in my case I found the bullet behind the head of the tibia. If you will try a funnel made of lead, I believe you will find the foreign body every time.

*When Dr. Hodges uttered these words technique in the use of the x-rays had just commenced. There is no difficulty now in skiagraphing impacted fractures showing plainly the limitation of bony tissue imbedded in and beneath bone. New bone in united fractures and also provisional callus is also observed in the fluoroscope and shown in the sensitized plate. Ed.

Dr. C. K. Cole, of Helena, Mont., also read a most excellent paper before the Academy in which he said:

"Even in cases of compound comminuted fractures with considerable injury to the soft tissues, with the aid of anesthesia, the x-rays and surgically clean methods, why should not each spiculum and fragment be replaced, the torn periosteum carefully attended to, the wound left in an aseptic condition and a satisfactory issue anticipated?

"I believe that the present generation will see the x-rays and fluorescent screen in practical every day use to such an extent that the surgeon will, with the aid of these adjuncts, together with the use of progressive aseptic and antiseptic methods, obviate many of the terrors formerly attached to the practice of bone surgery."

In the discussion Dr. W. Grant, of Denver, Col., said:

"In a case that has recently come under my care I have taken three or four pictures with the x-ray to see the position the bone was in, and I defy anyone in examining the arm with the eye and hand to show a particle of malposition; the result is a good one. The x-ray showed the upper fragment overlapping the lower, which was caused in not being able to flex the arm perfectly. The fracture involved part of the fossa of the olecranon and the coronoid process. How to meet those indications and the action of those muscles is a question the future must determine."

THE Surgeon General of the U. S. Army has approved the purchase of eighteen x-ray apparatus to be used for field and hospital service. Two of the machines are to be sent to Manila.

Preliminary Observations on the Treatment of Congenital Dislocation of the Hip by the Lorenz Method of Forcible Correction, With the Report of a Successful Case.

BY ROYAL WHITMAN, M. D., NEW YORK.
Instructor in Orthopaedic Surgery in the College of Physicians and Surgeons, Chief of the Orthopaedic Department of the Vanderbilt Clinic, Assistant Surgeon to the Hospital for Ruptured and Crippled.

The Lorenz treatment is based upon the theory, that if parts about the joint may be sufficiently stretched to allow the head of the bone to be brought into direct contact with the rudimentary acetabulum, and if it can be held in this position, the weight of the body, in walking, constantly forcing the bone against the substance that partly fills it, will gradually enlarge it to its normal capacity; thus it is called the "functional weighting" method, and this is its es-

FIG. 12.

Skiagram of congenital dislocation of the right hip, age 3½ years. Shows the elevation and displacement of the femur and the secondary depression on the pelvis, formed by the head of the bone.
After two unsuccessful attempts by the forcible method, the open operation was performed in July, 1897. The patient is cured, but is still wearing a protective brace.

sential and vital distinction from the forcible correction of Paci, with which it is often confounded.

[The first section of this valuable contribution to congenital hip joint surgery was printed in the April issue and concluded in the May number of *Pediatrics*, New York, one of the most instructive monthlies published in the English language. The article is illustrated with thirteen beautiful half tones. We reproduce herewith electros Nos. 12 and 13, which were kindly furnished by *Pediatrics*. Ed.]

LUMINESCENCE AND X-RAYS. Sagnac. *Rev. Gen. des Sc.*, April 30.—An article in which he gives a summary of his researches on the transformation of x-rays by substances which absorb them, thereby transforming them into new rays which are closely related to x-rays and at the same time approach the characteristics of extreme ultra violet rays.

FIG. 13.

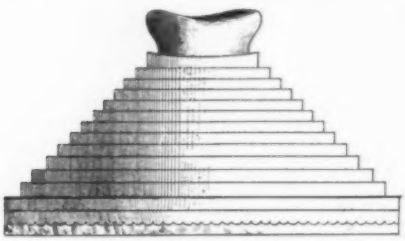
Skiagram of congenital dislocation of the left hip (from behind). Shows the effect of an unsuccessful operation, in which the dislocation has been transformed from a posterior into an anterior displacement.

X-RAYS IN TIME OF WAR.

BY FREDERICK STRANGE KOLLE, M. D.,
Radiographer to the Methodist Episcopal Hospital; Member of the Kings' County Medical Society; the Brooklyn Pathological Society, the Long Island College Hospital, and Kings' County Hospital Alumni Association, of Brooklyn, N. Y.

Now that hostilities have begun; when the eagles of war scream all around us, when sons of liberty and right, lay maimed and bleeding, let us not forget the humane addition of an x-ray apparatus to the field surgeon's armamentarium, for here and here especially can we utilize the rays of Roentgen to an extent never dreamed of in time of peace.

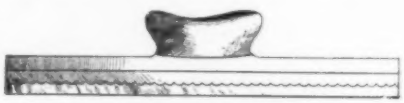
At first glance, we heave a sigh,—the impracticability of conveying the delicate machine strikes us with piteous force; but let us stop to think and to devise a ready means of transportation and utility! There is still ample time for deep contemplation and soon, "Mother Invention" comes to our aid, and nothing seems impossible.



The induction coil if properly made is a strong instrument, one that can readily stand the brunt of knocks and shocks without seriously affecting it, therefore we pass on to the possibility of producing a current necessary for it. Batteries seem to me to be the proper source. For this purpose cells made of stiff (not hard) rubber and fitting one into the other could be safely used; they require little room in such form and will not be injured. The elements can be safely carried in the form of carbon and zinc plates. Solutions can be made with water; the chemicals require little room and can be carried as part of the apothecaries' stores.

The construction of a fluoroscope, perhaps as important as the tubes, need not bother us, and for this purpose I suggest a telescope body of leather, as used in the camera with a metal (aluminum) base mounted with the fluorescent chemicals as usual. If protected on its inner side with a thin film of transparent gelatin or celluloid. The eye-piece may be made of heavy dark felt. In this form the fluoroscope can be carried in a surprisingly small space, indeed. It is peculiar that such form has not been as yet devised. The tubes should be of the long type, not spherical as they require more room, and be packed in light wooden cases, a protective layer of cotton will prevent injury with safety. Two or three focus tubes can be carried in small space. Wire can be coiled up and stowed away, inside of the cells, perhaps even with the chemicals.

I would suggest flexible cord for battery wire, so as to allow the moving about of the connected apparatus away from the cells, from place to place as required.



The necessary connections, solutions, etc., could be made in less than half an hour, at the highest, depending of course, in the solution used, and lo! we have the valuable addition quickly produced, ready to aid the busy surgeon in the location of ball or fracture and fewer men to come home from battle, decked with glory and proud scars, better united fractures and little cold lead, scattered mysteriously about the tissues of the body to remind the victim, forever in life after of the dark side and scenes of the battlefield!

THE EFFECT OF X-RAYS IN OPHTHALMOLOGY.

Presented at the Fourth Annual Meeting of the American Academy of Railway Surgeons, at Chicago, Ill., Oct. 6-8, 1897.

BY A. G. THOMSON, M. D.
Assistant Oculist, Pennsylvania Railroad.
Philadelphia, Pa.

In December, 1895, Professor Roentgen gave to the world his great discovery that an invisible ray, now known as the x-ray, produced by sending a current of electricity through a vacuum tube, had the power of penetrating solid and opaque materials and leaving its impress on a sensitive plate. Aside from its great scientific value, this event marks an epoch in the history of medicine comparable to such discoveries as anasthesia and of antisepsis. Although there are experiments being made throughout the world, and apparatus being perfected in every way, the new force, so far as its scientific or practical value is concerned, may be considered in its infancy and, as in the case of the discovery of ether and antisepsis, it has so far given its greatest aid to surgery, yet I am sure it will onlybe aquestion of time when, as we gain further knowledge of this power and effect further improvement in the apparatus used, we shall see that it will give equally valuable aid in medicine in determining the diagnosis of obscure pathologic conditions. The practical utility of this wonderful force was first demonstrated in surgery. Experiments were concurrently being made in all branches of medicine, and ophthalmologists especially watched the early developments with great interest.

As nobody knew the extent of the new, wonderful force, as with all unknown things, there was a vast field for speculation. Many of the enthusiasts claimed, and the claim was taken up by the newspapers of the country, that the new discovery would confer upon suffering humanity one of the greatest boons conceivable; it would give to the thousands of inmates in blind asylums vision to their sightless eyes. On the other hand, from a diagnostic point of view, for which we had hoped so much, we experienced immediate disappointment. All experiments showed that owing to the unfortunate position of the eyeball, surrounded by the bony walls of the skull, which were at that time thought impenetrable to the rays, the value of the x-ray in determining the presence or in locating foreign bodies in the eye, was practically negative. As regards the hope of producing vision in the blind, these experiments, so far, have shown that for any practical benefits the x-ray is useless. Dr. Brandt[1] stated, at an early date, that by removing the lens, the retina becomes sensitive to the x-rays. This was immediately contradicted by Bullot,[2] who showed that the lens was also transparent as other neighboring tissues of the eye, the difference being due to their densities.

Experiments made by Dr. Hansell and Dr. Max Stern,[3] at the Philadelphia Polyclinic, on patients with defective vision, as leucoma of the cornea, capsular and lenticular cataract, central scotoma, due to a large patch of central retinal choroditis and atrophy of the optic nerve, showed that patients were unable to see any more clearly through the fluoroscope than before the production of the rays. This is confirmed by the report of Dr. Wilkerson, of the California School of the Blind. He selected six patients for testing, one with destruction of the anterior portion of the eye from an old traumatism, one with complicated congenital cataract, one with partial phthisis bulbi from ophthalmia neonatorum and three with optic nerve atrophy. In none of these cases did the

1 Revue general des Sciences de Paris, No. 21. tome VII, p. 897, Nov. 15, 1896.
2 Revue d'Ophthalmologie, February, 1897.
3 Polyclinic, Philadelphia, 1897.

rays assist the vision in the slightest degree.

Boch[4] suggests that persons blind from the loss of transparency of the media might be able to read letters painted on a card varnished and dusted with a powdered metal, if these were subjected to the action of the x-rays. This is impracticable unless a fluoroscope or some other fluorescing screens, by which the shadows are rendered visible, be placed back of the opaque lens or cornea. Otherwise the source of illumination is no more available than before. All these experiments, I think, show conclusively that the x-ray, as it is known today, will be of no practical value to the blind; and this would seem also theoretically correct, as we know our retinas are only able to perceive a very small portion of the spectrum, namely, (1-20) that portion where the vibrations in the ether extend from four hundred million millions to eight hundred million millions of light. Vibrations of lesser frequency, although not seen, are demonstrated by certain instruments of precision, while vibrations above this number are known as the ultra-violet rays, invisible to the eye but demonstrated by a photographic plate. Now, as the rays are emitted from the tube at a very high rate of vibration, they may be conceived as analogous to the ultra-violet rays which are not perceived by our retinas, and no matter how much they are capable of penetrating obstacles to vision, they could not make the blind see when they are invisible to the normal retina.

As time progresses and as one series of experiments after another confirm the want of value of the ray in helping the blind, we are agreeably surprised to see the advances made in the other direction, from a diagnostic standpoint, which at first thought appeared so discouraging.

Among the most serious complications in the practice of ophthalmology and one that always gives the surgeon the greatest anxiety, is the severe traumatism of the eyeball produced by a foreign agent, causing the coats of the eye to be penetrated, and where the presence or absence of a foreign body in the eye is not known. The traumatism may be great enough to destroy the eyeball for all practical purposes of vision, but the anxiety of the surgeon does not end here, for if a foreign body remains within the eye there is always the danger of the dreaded sequelae of sympathetic ophthalmia.

In the majority of cases of this kind, we are able to satisfy our minds as to the presence or absence of a foreign body by the history of the case, subjective symptoms and theoretic considerations leading us to a positive conclusion; but there are many times when owing to the obscure history, lesions of transparency and great destruction of the eyeball, our previously known methods of diagnosis are not available. That a positive means of determining the presence or absence of a foreign body would be of the greatest benefit in such cases is unquestionable, and I thoroughly believe we have attained the ability of not only determining the presence of the body, but exactly locating it in the eye by means of the x-rays. This does not pertain to particles smaller than the one thirty-second of an inch. The experiments at first were discouraging, and this was most probably due to the incomplete apparatus. Dariex[5] conceived that the low degree of permeability of the eye by the x-rays would undoubtedly be ineffectual in producing a radiograph. By others who worked with tubes of low penetrating power it was found that the eye, surrounded as it was by the bony walls of the skull, would be an insurmountable obstacle to the production of a radiograph. Van Duyse[6] stated that

4 Minor abelin, February, 1897.

5 Annal d'Oculistique; t. 115, p. 218.

6 Archive Ophth., Tes., 1896.

the anterior portion may be radiographed and suggests the procedure of injecting a salt solution under Tenon's capsule to make the eye protrude. Lewkowitz[7] showed that he was able to make a radiograph of the lids and summit of the cornea, and to determine, by an elaborate method of figuring, the position of a gilt spangle placed in the conjunctival sac.

Harnisch[8] says, as the eyeball is almost entirely surrounded by bone, which is practically impenetrable to the rays, we could only hope to discover a foreign body as far back as the ciliary region or, in particularly prominent eyes, a trifle further.

The first cases reported that were of any practical diagnostic value were by Williams[9] and Clarke.[10] Both these gentlemen by their results, show that the ray will penetrate the bones of the skull, and, if a foreign body is in the eye it will throw a shadow on the plate dense enough to be seen. Williams placed his patient on a table, with the cheek of the injured side resting on the sensitive plate, and allowed the rays to pass through the nasal bones and through the external wall of the orbit; while Clarke inserted a sensitized film into the nose and placed the tube to the outside of the temple. The reports of this case were followed during the next fall and winter by those of Hansell, De Schweinitz and Oram Ring,[11] assisted by Max J. Stern, who bandaged the plate to the side of the temple. Friedenburg[12] allowed the rays to be passed from behind the head and to strike a small sensitized plate which was cut to fit into the margins of the orbit. In all these cases the foreign body was successfully removed from the eye. These cases are exceedingly interesting, as they show a decided step in advance. They not only demonstrate that the bones of the skull can be penetrated by the ray, but the whole extent of the eyeball can be radiographed, although they all fail in giving us an accurate means of locating the position of the foreign body.

The methed of not only showing the presence of a foreign body, but at the same time definitely localizing its position in the eyeball, was shown by the case recorded by Dr. Oliver,[13] assisted by Dr. Leonard, and by Dr. William Thomson,[14] assisted by Dr. William Sweet of Philadelphia. Dr. Oliver's plan is opposed to that brought forward by Exner,[15] in the fact that the base line for triangulation is made anterior to the cranial shadow, and the exposures are repeated sufficiently often at fixed distances and set situations so as to give a multiple series of relational sides and angles from which the exact position of a foreign body can be accurately determined. This is a very good method and has been successful in several cases, by Dr. Oliver, although not as clear and practical for the surgeon as Dr. Sweet's method.

As I have had the advantage of personally studying the case reported by Dr. William Thomson, from entrance to leaving the hospital, and also of using the method devised by Dr. Sweet in localizing the foreign body in cases of my own up to this time, I think that it is the most successful method known to insure the required degree of accuracy. The details of the case can be seen in the report of the proceedings of the American Ophthalmological Society, but it is sufficient to say here that the patient was struck in the eye by a piece of steel, some eight months before presenting

7 Lancet, 1896, II, p. 452, and Centralbl. f. Prakt. Augenheilk., January, 1897.
8 Annal. Oph. and Otol., 1896.
9 Trans. American Ophth. Society, 1896.
10 Ibid.
11 Am. Oph. Transactions, 1897.
12 N. Y. Med. Rec., 1886.
13 Am. Opn. Transactions, 1897.
14 Trans. American Oph. Society, 1897.
15 Deutsche Medicinische Wochenschrift, Jan. 7, 1897.

himself to the hospital with an exceedingly painful eyeball. The wound of entrance was plainly visible to the outside of the cornea, and an ophthalmoscopic examination showed a dense band of lymph extending trom the wound of entrance to the retina, slightly external to the disc. The important diagnostic point to determine in this case was whether the steel was present in the eyeball or had penetrated and lodged in the orbit, in a benign position.

The case was radiographed by a series of pictures, each one of which showing the exact position of the foreign body. Dr. William Thomson operated, making an incision in the sclerotic and inserting a magnet, but without any result. However, having great confidence in the method, he picked up the band of cicatricial lymph with a strabismus hook, following it to its final insertion, the retina, excised it and, to his great pleasure, found the foreign body in it at the exact position as demonstrated by the radiograph. The magnet was not successful, as the steel would not attach itself owing to its partial covering of lymph.

The other point illustrated by this case is that it showed accurately the foreign body, inside the eye instead of the orbit. I had an opportunity of seeing a case a short time ago where the eye was enucleated for a supposed foreign body. After enucleation a piece of steel was found to be lodged in the orbit, having completely penetrated the eye. An x-ray picture would undoubtedly have demonstrated this and saved the patient a serious operation and allowed him to retain the eyeball without danger. The case of Dr. Thomson not only shows the x-ray as an important means of diagnosis in these cases, but also as a great help to the operator in removing the foreign body after its exact localization.

Another case which has come under my care recently, although too early to state positive results, will help to show the advantage of the x-ray in diagnosis, in a negative way, by excluding the presence of a foreign body. A man some seven weeks ago was struck in the left eye by a small piece of flying steel from a rivet. He immediately went to a hospital in New York, and was told by the surgeon that he thought the steel to be in the eye, but preferred treating him conservatively for a few days. After a treatment of a week, as a traumatic cataract was probably forming, preventing observation of the interior of the eye, and symptoms increasing in severity he advised the removal of the ball. The man declined and consulted another surgeon with the same result. He presented himself before me with the following appearance: The eye slightly red, cornea clear, linear scar three millimeters, in the upper and inner periphera of the cornea, also wound of the iris, immediately back of the wound of the cornea, this having the appearance of being dragged in as if it had been punctured, and a small synechia of the pupillary margin, dense, traumatic cataract, ball painful, fields good. I had the eye radiographed and six plates taken on the first day. These showed no signs of foreign body, but owing to the great heat of the weather, the developing was unsatisfactory. Thinking heat might have affected the plates, another trial was made the next day, and this time eight plates were taken. These were all good radiographs but no sign of the foreign body was visible. I therefore decided to be governed by the radiograph in the treatment of the case, and thereafter regarded it as punctured wound without the presence of a foreign body. As the lens became somewhat swollen I did a cataract extraction combined with an iridectomy, incising the iris at the point of injury, thinking I might find the foreign body at the lens or iris. This also proved fruitless. The

case recovered from the operation and is doing exceedingly well, and I firmly believe, although too early to state positively that as there is no foreign body present in the eye, the man will retain not only his eye but his vision.

Ophthalmology is undoubtedly indebted to the x-ray, as it has added another accurate method in diagnosis of the injuries complicated by presence of foreign bodies.

As regards the deleterious effects of the x-ray, they are small in comparison to the great benefits derived. I have seen several instances of the hair falling out and slight dermatitis, but this is always due to the fact of the vacuum running down and the rays not penetrating, and to long exposures. I have never seen any serious damage to the eye.

[Dr. Thomson then showed the apparatus and demonstrated Dr. Sweet's method of localizing from the charts made in the case of Dr. William Thomson. The following description being given by Dr. Thomson from "Transactions of the Ophthalmological Society" for 1897:]

For this purpose an indicating apparatus is used, carrying two steel rods, each with a rounded end. The indicators may be supported by a head band, and the plate held to the side of the head by an ordinary bandage. The balls of the indicator are at a known distance apart, one pointing to the center of the cornea, and at a known distance from the eyeball, while the other is parallel to the first, toward the external canthus. The visual line is parallel to the indicators and to the plate. The balls should also be perpendicular to the plate.

In making the negatives the tube is in front, about thirteen inches from the plate and at an angle of from 15 to 40 degrees, with a vertical plane passing through the apex of each cornea. The plate is at the opposite side of the head, and the rays pass through the eyeball and the external orbital wall before reaching the sensitive film. Two exposures are made, one with the tube in a horizontal plane, or nearly so, with the two indicators, and the second at any distance below. The angle of the tube below the horizontal is unimportant, so long as the two exposures give different relations of the indicators on the negatives.

In determining the position of the foreign body in the eye, two circles,

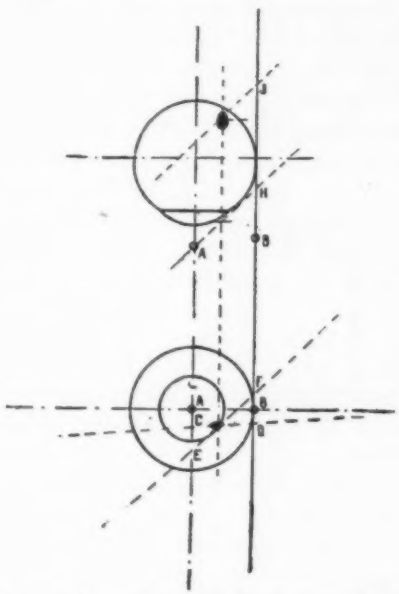


FIG. 1.—Diagrammatic circles of the eye upon which the measurements are made to show location of foreign body. Upper circle horizontal section; lower circle vertical section of eyeball.

twenty-four millimeters in diameter, equivalent to the size of the globe, are drawn upon paper. One circle represents a horizontal section of the eyeball, and the other a vertical section. Upon the vertical section a spot (A) is made at the center of the circle, indicating the position of the central indicator of the apparatus. The distance between the two indicators is measured toward the temporal side, and a spot (B) made to show the position of the external indicator.

On the circle representing a horizontal section of the eyeball, a spot (A) is made anterior to the center of the cornea, and at the same distance that the center indicator was from the eye when the radiograph was made. Another spot (B) to the temporal side, measured by the distance between the two balls of the apparatus, marks the situation of the external indicator.

Taking the first negative with the tube nearly horizontal to the two indicators, we measure the distance of the foreign body below to the two balls of the apparatus. These measurements (B to D and A to C) are indicated on the circle representing the vertical section of the eye, and a line is drawn through the points (C, D). At some point along this line is situated the foreign body. From the second negative (Fig. 3), made with the tube below the plane of the two indicators, the measurement is taken of the distance (A, E). The shadow of the foreign body is below the center indicator, and this point (E) is indicated on the first circle. The distance the foreign body is above the external indicator (B, F) is measured, and tne point indicated on the circle at (F). Where a line drawn through these two points crosses the line of measurements made from the first plate is the situation of the foreign body, as respects its horizontal and vertical position in the eyeball.

To determine the distance of the foreign body behind the apex of the cornea, the negative made with the tube nearly horizontal is taken, and a measurement made of the distance the shadow of the center ball is posterior to that of the external ball (B, H). The distance is entered directly above the external ball on the diagram representing the horizontal section of the eye. From this point (H) a line is drawn through the ball (A) of the center indicator, which indicates the drection of the rays from the tube when the exposure was made. Taking the negative again, we measure the distance that the shadow of the foreign body is back of the external indicator. The distance (B, J) is marked perpendicularly to the spot representing the ball of the external indicator on the diagram, and a line is drawn parallel to the direction of the rays from the tube (A, H). Where this line cuts a line perpendicular to the position of the foreign body shown on the vertical section of the eye-ball is the dis-

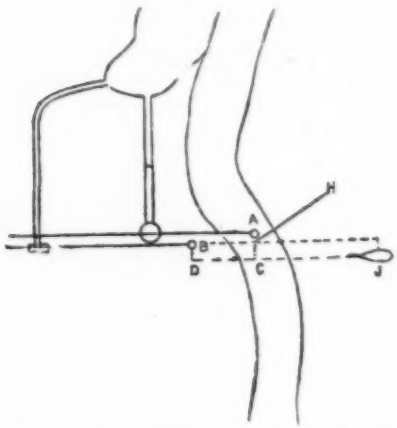


FIG. 2.—Outline drawing of negative made with tube nearly horizontal.

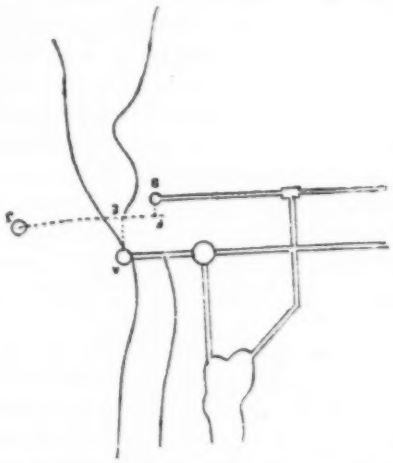


FIG. 3.—Outline drawing of negative made with tube below the plane of the two indicators.

tance the foreign body is behind the anterior portion of the cornea."

DISCUSS ON.

DR. D. C. BRYANT, of Omaha.—On account of the location of the eye within its bony cavity, it is difficult to find a foreign body with the x-ray or anything else in many instances. It is exceedingly difficult to locate the exact position of the foreign body. The use of the x-ray, so far as the eye is concerned, will always be somewhat limited in those few cases where we need help. If in a few cases it does help us to locate foreign bodies, or to prove that there is or is not a foreign body in the eye, it will be of great advantage. Outside of the eyeball itself, in the orbital cavity where we have larger foreign bodies, we know it is of great value.

DR. ARTHUR D. BEVAN, of Chicago.—I imagine that this method of locating a foreign body in the eyeball might be enlarged and applied to the location of foreign bodies anywhere in the orbit, and I think it is very valuable because of the recent experience I had in removing a bullet from the orbit, which I reported six months ago to the Chicago Medical Society. In this case a thirty-eight-caliber bullet struck the temporal bone. Probing could not locate it. There were no cranial symptoms. A blood clot, evidently in the orbit, protruded the eye. There was complete blindness for some days in the eye on that side. Within a couple of weeks the eyesight began to return. I had an x-ray picture taken and it located the bullet from one plane, but it was impossible to obtain good x-ray pictures at right angles in order to locate exactly its position. However, I determined from an analysis of the data at hand, with the x-ray picture, that the eye had been blind for some days afterward and pushed out of the orbit, and that the bullet must be somewhere in the orbit behind the eyeball. With that conclusion I operated and removed the bullet, but it took me an hour and a half. I had the general location of the bullet, in one plane, sufficiently accurate in my mind, but I was certainly three-fourths of an inch off in my position in the other plane, and in operating in the posterior portion of the orbit, in the position of the nerves and optic artery, I found it was slow work. I feel satisfied that the work could have been much simplified by an apparatus such as Dr. Thomson describes, and I can readily understand its great value.

As to the statement made in the paper that the disadvantages of the x-ray, using it in a wide sense, are very small and do not at all weigh against the advantages; there are disadvantages in the x-ray that we, in Chicago, are very familiar with, and I think from the reports of cases tabulated and published in the *Johns Hopkins Bulletin*, in regard to the injurious effects of the x-ray, should be very generally known.

I know of some cases in which great injury has been done by the x-ray. We are all familiar with the dermatitis which follows the use of the x-ray. I have seen two cases in which this effect has been extreme, followed by total destruction of skin, the superficial and deep fascia, and the existence of an ulcer for months after the use of the x-ray. I have also seen total destruction of the eye from the use of the ray and absolute loss of the ear from it. These are points which we should keep prominently in mind.

At the meeting of the American Surgical Association, held in Washington this year, Dr. White, of Philadelphia, read a paper on the same subject which seemed to belittle the possibilities of doing damage with the x-ray. I think we should all be very cautious of this. These serious effects are not so apt to occur now as they did heretofore, because the exposures are much shorter, and serious damage rarely follows expos-

ures of fifteen or twenty minutes. So much is thought of the injurious effects following the x-ray, in Chicago at least, that the majority of men do not, themselves, take x-ray pictures. They throw the responsibility on the photographer, so much so, that one whom I know, practically compels patients to sign a contract to assume all responsibility of injury when he takes an x-ray picture. I feel quite positive that the days of serious dermatitis and injury from the x-ray are numbered, because it is better understood and the exposures are shorter. But these injurious effects should be kept in mind and be widely known. They should be known to the patient who undergoes the x-ray exposure. We have no right to expose a patient without informing him of the possibilities. It should be done in order to protect surgeons from malpractice suits, and the photographer should be cautioned to exercise great care in the use of the ray.

DR. R. HARVEY REED, of Columbus, Ohio.—I think the idea of using "triangulation" for the purpose of locating an object is a very valuable one, and it will undoubtedly aid us in locating bodies in the eye as well as in other parts of the body. But there is one point I will speak of, and that is the possibility of damages accruing from making an operation when the x-ray fails to locate what the surgeon is looking for. Here is a medico-legal point which is of no small importance, because, if the radiographist says that a foreign body of some kind is located thus and so and advises me to make an operation for its removal, and I make the operation and fail to find the foreign body, supposing it did not exist, then where would I stand from a medico-legal point of view? In the use of the fluoroscope and the x-ray in the bullet case which I reported this afternoon, the track of the spot was located nearly above the ear and a little above and back of the eye, and the radiographist, although not certain that was the point at which the bullet was located, felt quite sure that was the point at which we would find the bullet. I was not convinced and resorted to the ordinary methods that I would have used had I not had a radiograph taken, and the consequence was I trephined over the point of entrance and found the bullet in the skull as I had located it. Had I made the opening as indicated by the radiograph I would not have found the bullet, and the operation might have been followed by bad results. By using triangulation for the purpose of locating foreign bodies we can thus avoid, to a large extent, the possibility of making operations where no foreign body exists, or where we are mistaken as to its actual location.

DR. S. C. BALDWIN, of Salt Lake City, Utah.—Reference has been made to the paper read by Dr. Willard before the American Medical Association, and in all of his experience the tube has been placed not closer than from twelve to fifteen inches from the body. As a result he has never seen any dermatitis, sloughing of the skin or anything of that kind. It is a point that might be considered in using the x-ray for this purpose.

DR. JAMES BURRY, of Chicago.—Where crude methods have been tried in the location of foreign bodies in the body, they have not been successful in a great many instances.

The tabulation of errors by the x-ray process is valuable for us. Dr. Reed would have been in the same position if he had trephined for the bullet where the skiagrapher thought it was, as the man that cuts into a foot for a needle that is in there and does not find it. The needle is there, perhaps, but not where it is located by the x-ray process. If we report such cases it will have value in giving the process its true standing, and I think its medico-legal relations

will soon be settled. I imagine that the greatest difficulty Dr. Thomson would experience in these cases is to get correct pictures. I have tried many times to get pictures of the eye, and through the nose, and have not been very successful.

DR. THOMSON.—I think our results in the use of the x-ray are largely due to the apparatus that we use. It is perfectly evident that the tubes formerly used were so small and imperfect that it was extremely difficult to take a good picture of the orbit such as I have described.

I am not sufficiently familiar with the pathologic conditions in fractures, etc., to say much about it. However, I should think that if a series of pictures were taken with a good apparatus, they would be valuable both from a diagnostic and medico-legal point of view.

I have seen cases where the hair has come out, and again where the patients have had a slight dermatitis. Some gentleman has devised a scheme which prevents dermatitis, or any deleterious effects, by allowing the x-ray to pass through a small film of gold leaf.

RAYLEIGH ON STOKES.—Sir G. Stokes, about two years ago, suggested a theory of the Roentgen rays, according to which the Roentgen rays were regarded as aperiodic electro-magnetic waves caused by the impact against the anticathode of the charged particles in the cathode stream. This theory has recently been developed by J. J. Thomson (*Phil. Mag.*., Vol. 45, p. 172, 1898), and has come much into favor with other authorities. In *Nature*, April 28, however, Lord Rayleigh raises a protest against the acceptance of this theory. He says it has certainly much to recommend it, but he can not see that it carries with it some of the consequences which have been deduced as to the distinction between Roentgen rays and ordinary luminous and non-luminous radiation. The conclusions of its supporters "that the Roentgen rays are not waves of very short length, but impulses," surprise Lord Rayleigh. From the fact of their being highly condensed impulses, he would conclude, on the contrary, that they *are* waves of short wave length. He asks what becomes of Fourier's theorem and its assertion that *any* disturbance may be analyzed into regular wave? The view that the vibrations of ordinary light are regular, and thus distinguished from disturbances made up of impulses, he says, is an exploded idea, in the theory of light. A curve representative of white light, if it were drawn on paper, would show no sequence of similar waves. Rayleigh favors the view that Roentgen rays differ from ordinary light only in the shortness of their waves. — *Electrical Review*, London.

EXPERIMENTS WITH X-RAYS.—The stomach movements of a cat have been studied by Dr. W. C. Cannon, by means of Roentgen rays. Subnitrate of bismuth mixed with the food caused the wave-like movements of the pyloric portion of the stomach to become clearly visible, about 2,600 of the waves being counted during the seven hours a cat was digesting soft bread. A Frenchman, M. Bleunard, uses the x-rays for measuring the adulteration of flour with chalk and sand. Comparing the shadows of the sample under investigation and of others of known adulteration, it is easy to determine the proportion of foreign matter when as small as three per cent.—*London Electricity.*

THE latest use of the Roentgen ray is for the diagnosis of cerebral tumors. One case of sarcoma of the dura has already been successfully located by this means.

ADJUSTABLE X-RAY TUBES.

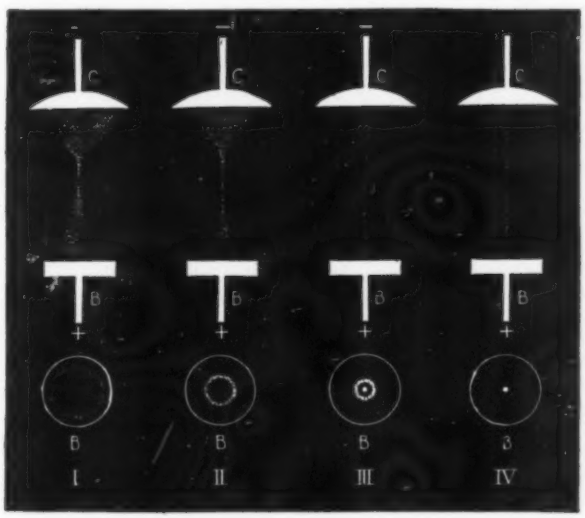
BY A. A. C. SWINTON.

The Crookes radiant matter tube, in some form or other, affords the only known means by which the Roentgen rays can be generated, and it is, therefore, perhaps not altogether inappropriate that the first ordinary paper communicated to the Roentgen Society should deal with the design of tubes of this description. As most of those who worked with the various forms of tubes originally employed for producing Roentgen rays will not readily forget, these had many imperfections, and there can be little question that the first real advance after the announcement of Roentgen's discovery, was Mr. Herbert Jackson's adaptation of Crookes' focus tube to x-ray purposes. The focus tube gives a quantity of x-rays not obtainable with the older forms. It is much less liable to be cracked or injured by the heat of the discharge, while as the x-rays all proceed from a very small area, a degree of sharpness is attained in the resulting screen-image, or photograph, that was previously quite unobtainable. The focus tube as originally introduced, though a vast advance on all previous arrangements, is not without its imperfections. Dr. MacIntyre was, I believe, among the first to call attention to the importance of using electric discharges of great electrical quantity in order to produce the best results. These heavy discharges give a much brighter screen, or what is the same thing, they enable photographs to be taken with much shorter exposures. They also cause the x-rays to be more penetrative, but at the same time they are very hard upon the tubes. With the focus tubes of the original form, heavy discharges will frequently twist up or even melt the platinum, and will usually make it red or white hot. This leads to blackening of the tubes, and to a gradual increase in the resistance, till eventually no discharge can be got to pass.

Recognizing these defects, I set myself some little time ago, in conjunction with Mr. J. C. M. Stanton and Mr. H. Tyson Wolff, the task of investigating the action of the focus tube, with the idea of, if possible, improving the design, so as to admit of heavy discharges being employed, with the view of obtaining easily and continuously the most active and penetrative x-rays possible. At the same time, seeing the great variation of the character of the x-rays that occurs with very small changes in the degree of exhaustion, and the practical difficulty of obviating such changes in practice, I endeavored to discover some ready method of adjustment more certain and more easily worked than the auxiliary pumps, potash tubes, and other similar appliances that had at that time been used or suggested for this purpose.

When a focus tube is carefully examined while under the process of exhaustion on the mercury pump, the form of the cathode discharge is found to alter from the initial appearance shown between the cathode C and the anti-cathode B, in Fig 1, at a low vacuum, through the appearance shown in Figs. 2 and 3, to that illustrated in Fig. 4, which shows the appearance when the vacuum is high. As will be observed, the cones of cathode rays in each case converge from the cathode cup to a focus, and then diverge again on the other side of the focus to a less and less extent the higher the vacuum. Finally, at a high degree of exhaustion the cathode discharge does not appear to diverge again very perceptibly, at any rate, within a moderate distance, but continues in a thin line. It is when this stage of exhaustion is reached that Roentgen rays are given off in their most active and most penetrative form. Experiments show that both the convergent and divergent

cones of cathode rays are hollow, and not solid in section. When the concentrated cathode rays are allowed to fall upon a disc of ordinary electric light carbon, the latter exhibits surface luminescence. Except, however, when the disc is exactly at the focus, in which case it shows a bright luminous spot, the intersection of either cone by the disc gives not a solid spot of luminescence, but a hollow luminous ring, which decreases in diameter the higher the exhaustion, as shown in the lower portion of Figs. 1 to 4. It appears



FIGS. 1, 2, 3 AND 4.

further that the cathode rays are not given off from the whole surface of the cathode cup, but only from a ring-shaped portion, the diameter of which is less and less the higher the exhaustion. This, perhaps, explains the reason why very large cathodes give no better results in producing x-rays than comparatively small cathodes. Indeed, at the degrees of vacuum necessary to produce penetrative x-rays, the greater portion of a very large cathode is apparently ineffective, as the discharge seems to come off entirely from a very small part of the central portion. This is not readily seen with the usual cathode cups of aluminum, but with cups of carbon it is easily observed. Full details of the experiments from which the above facts are derived, will be found in "The Proceedings of the Royal Society," Vol. LXI., pages 79 to 95.

Cathode rays are generally believed in this country to consist of atoms of molecules of residual gas, which being similarly electrified to the cathode, are repelled by the latter, and travel at an average velocity not much less that one-twentieth that of light. It is obvious, however, that upon such a theory the precise average velocity must depend both upon the exact potential of the cathode and molecules at the moment the latter leave the former, and also upon the degree of exhaustion of the tube, upon which depends the free path of the molecules—that is to say, the distance a molecule can travel before coming in contact with another molecule. Years ago Crookes showed that the deflection of a cathode beam by a magnet depended upon the excitation of the cathode, and upon the degree of exhaustion—that is to say, the deflection was less the higher the velocity of the molecules. More recently Birkeland has produced what he calls "the cathode ray spectrum," from which it appears that the cathode rays are not homogeneous but heterogeneous, some being more easily deflected than others, so that when the cathode stream, passed through a slit, is deflected by a magnetic field, and is then allowed to fall on the glass and cause fluorescence, the result is a series of bands. These bands are in a perpetual state of movement, and

the conclusion is obvious that the molecules that form the cathode stream are not all moving at the same rate, but owing to the pulsatory and oscillatory nature of the electric discharge and the varying electrification of the cathode are divided up into groups, which have different velocities, and, being for this reason differently deflected, strike the glass and cause fluorescence in separately localized bands.

Now, as Prof. S. P. Thompson first pointed out, and as all who have since observed the effects produced on a fluorescent screen while a focus tube is in process of exhaustion, and is at the same time being excited, are aware there are several different stages as regards the x-rays produced. First of all, at less than a certain vacuum there are no x-rays; next, as the vacuum increases, x-rays show themselves, but of a quality that will do little more than penetrate the backing of the fluorescent screen. As the vacuum is further increased the rays become more penetrative and show the bones in the hand. Next, a point is reached, when the flesh of the hand seems to be almost completely transparent, while the bones are almost entirely opaque; at still higher vacua, the bones becoming more and more transparent, the contrast between bones and flesh becomes less and less, till at length, at the very highest vacuum at which the discharge will pass, the bones scarcely show at all, owing to their having become almost as transparent as the flesh, and the whole hand throws but a very faint shadow on the screen.

Again, what I have termed the "penetrative value" of the rays is found to be dependent upon the applied electromotive force, that is to say, the difference of potential between the cathode and anode, and the conclusion seems to be irresistible that on the assumption that the cathode rays consist of rapidly moving molecules, which by bombardment of the anticathode cause x-rays to originate, that the penetrative value of the x-rays depends upon the velocity of these molecules at the moment they strike the anticathode, and to the difference of potential between molecule and anticathode at the moment of impact, or to one or other of these conditions.

I must again refer to Prof. S. P. Thompson's experiments as to the value of different materials for the anticathode, as he was, I believe, the first to discover that the higher the atomic weight of the material the better the result. Further experiment, however, shows that while what I may call the quantity of x-rays produced as measured in terms of the brightness of the fluorescent screen, or in inverse terms of the length of exposure necessary to impress to any given degree a photographic plate, is largely dependent upon the material of the anticathode being greatest with anticathodes of the highest atomic weight, the penetrative value of the rays—that is to say, their powers of penetrating opaque substances—is independent of the material of which the anticathode is constructed. For further particulars on this subject I may refer inquirers to "The Proceedings of the Royal Society," Vol. LXI., pages 222 to 226.

To come now to more practical matters, metallic uranium, which is the element with the highest atomic weight, (240) is commercially unobtainable at present. It is to be hoped that this state of affairs will not continue, as in addition to uranium being probably the most efficient emitter of x-rays, it is also stated to have the great further advantage of not blackening the glass, even after prolonged use. Thorium (atomic weight 231) and thallium (203) being also commercially unknown, and bismuth (208), lead (206), mercury (199) and gold (197), being too easily fusible, platinum with an atomic weight of 194, and a very high fusing point, is the best

obtainable material for the anticathode surface.

As platinum is, however, expensive, and thin sheets are apt, if unsupported, to be fused, pierced, or deformed under the bombardment and intense heat, I have found it desirable to mount the platinum disc on a larger and much thicker disc of cheaper metal, which not only supports and prevents mechanical deformation of the platinum, but also acts as a dissipator of heat, in addition to lessening the blackening of the glass, owing to there being only one platinum surface exposed.

In the tube I have now in my hand, which was the first constructed in my laboratory on this plan, the platinum is simply a piece of foil soldered with silver solder upon one side of a penny. Copper or bronze are, however, not good materials to introduce with a high vacuum tube, for as will be observed from this specimen, which has been a good deal used, they are apt, even more than platinum, to cause considerable blackening of the glass, and this blackening tends to increase the resistance of the tube to the electrical discharge.

A much better backing for the platinum is undoubtedly aluminum, but here the difficulty arises that it is very difficult, if not impossible, to solder platinum on to aluminum, and a good contact between the two metals is necessary. A simple plan, and one that has been found very efficacious, is to make the platinum in the form of a disc—say, about 0.4 inch diameter, and about 0.02 inch thick. The aluminum may be 1 inch diameter and 0.25 inch thick, and upon the face of it there is turned a shallow circular depression, just of sufficient diameter to receive the platinum, but rather deeper than the thickness of the latter. The platinum is tightly wedged into this depression, the edges of which are slightly riveted over the platinum by hammering.

It has been thought by some that there is an advantage in making the anticathode and the anode of an x-ray tube separate, the idea being that in this case there is less blackening. This idea I believe to be erroneous, provided the suface of the electrode which performs both of these functions is sufficient to prevent heating, and provided, as is always best, a small spark gap is introduced into the circuit so as to stop out entirely the make current of the induction coil or any reverse oscillation in the discharge which otherwise would during their continuance make the anticathode the cathode for the time being. There can be no doubt, however, both for the permanence of the vacuum and also for the prevention of blackening, of the importance of preventing the overheating of the anticathode, and though the mass of aluminum I use and recommend is very efficacious in this direction, I am of the opinion that as more and more electrical power is employed in order to obtain better and better results, some other arrangement for taking away the heat—say, in the direction of water or mercury circulation through the anticathode—will be found advantageous.

As already mentioned, one of the results of a red or white hot anticathode is a rapid deposition of platinum and blackening on the glass. This finely divided coating of platinum occludes the residual gas and causes the vacuum to become too high. Heating the glass will to some extent restore matters to their proper condition temporarily, but, apart from the degree of vacuum, the blackening seems also to have an effect in increasing the resistance of the tube, which is very probably analogous to what Crookes discovered when he found that a non-fluorescent coating on the inside of a tube increased the resistance of that tube to the passage of the electric discharge.

The precise distance between the

cathode and the anticathode is not of great importance, provided the degree of exhaustion is suitable, and provided the anticathode is beyond the focal point at which the convergent cathode rays meet together at low exhaustions. It is well, however, not to fix the anticathode too far beyond the focus, as this necessitates a higher exhaustion in order to obtain penetrative x-rays, and as too great a distance also impairs the sharpness of the resulting image.

The distance between cathode and anticathode has, however, a considerable effect upon the resistance of the tube, and upon the character of the x-rays it generates. In fact, adjustable tubes with which x-rays of any desired penetrative power can be obtained at will without altering the degree of exhaustion, or in which the unavoidable variations of vacuum which are found to take place in practice, can easily be compensated for, can be arranged with a movable anticathode mounted on a sliding rod, so that the distance betwen cathode and anticathode can be varied by gently tapping the tube.

In air at ordinary atmospheric pressure, the nearer the discharge points are together the more easily the spark takes place between them ; that is to say, the shorter the distance the spark has to leap, the less is the difference of potential required to make it leap. Curiously enough in high vacua the exact contrary is the case, and the discharge passes with much greater difficulty over a short gap than over a long one. This may be readily seen with an adjustable tube such as I will now show (Fig. 5), and in which I can alter the distance between cathode and anticathode by moving the latter. As will be seen when the distance is very small inside the tube, say only one-quarter of an inch, the spark prefers the alternative gap outside of about four inches, while if the internal gap is increased to about three inches, the discharge then prefers this path, and the exterior gap must now be shortened to about half an inch before the spark will travel that way. It is further

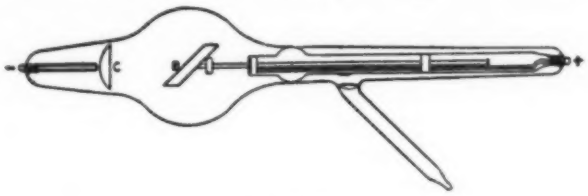


FIG. 5.

found that, in a tube of this description, exhausted to a constant vacuum, the nearer the anticathode is moved up to the cathode and the higher the consequent resistance, the more penetrative are the x-rays; while moving the anti-cathode in the opposite direction, and thus making the distance greater and the resistance less, makes the x-rays less penetrative. This form of tube was the first adjustable tube designed and made in

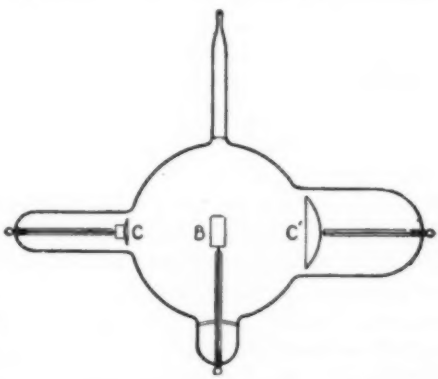


FIG. 6.

my laboratory, but this has now been superseded by others which have a greater range of adjustment, and are consequently to be preferred. One disadvantage that it possesses, is that the origin of the x-ray is moved for each adjustment. It has also the defect that, if the distance between the cathode and

the anticathode is made very great, so as to obtain much range, there is a tendency to a want of sharpness, owing to the x-rays being given off, not from a point, but from a considerable area. This, which has been observed in experiment, seems to show that, contrary to

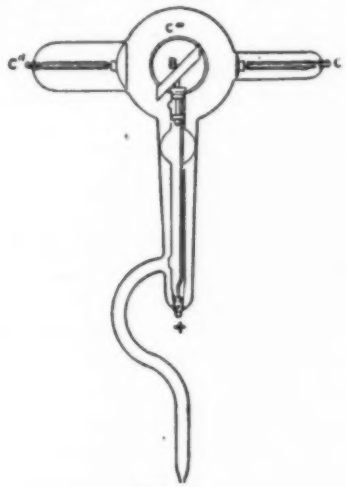


FIG. 7.

what has been stated by others, the cathode rays always do diverge again to some extent after passing the focus, though they do so at a greater and greater distance beyond the focus the higher is the exhaustion.

I have here an adjustable tube made by Messrs. John J. Griffin & Sons, which depends for its action upon the principle that I have just enunciated, namely, that the greater the distance between cathode and anticathode, the less penetrative, and the less the distance the more penetrative are the rays. In this tube, however, the anticathode is fixed, and it is the cathode that is movable, while the adjustment of the cathode is effected by the magnetic means, according to an ingenious suggestion of Dr. Dawson Turner.

The size of the cathode cup itself is also found to have a very great effect upon the penetrative value of the x-rays produced in any given vacuum. I have here a tube (Fig. 6) which is furnished with two cathodes, both of the same curvature (0.75 inch radius), but one of much greater area than the other, the larger being 1.125 inch, and the smaller 0.375 inch diameter. Both cathodes focus upon opposite sides of the same anticathode, which is placed midway between them. All are in the same tube, and consequently in the same vacuum. If I connect the larger cathode, leaving the smaller one for the moment idle, you will see that the x-rays produced are of a very poor penetrative quality, the result giving the appearance of too low an exhaustion. I now disconnect the larger cathode, and connect the small one. I now have an abundance of highly penetrative rays. I may further point out that the resistance of the tube as measured by the length of the alternative spark in air, is much less when the large cathode is in operation than when using the small cathode. Further, if this tube is more highly exhausted, so as to give rays of good penetration with the large cathode, the resistance with the small

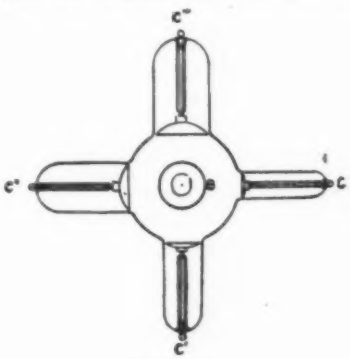


FIG. 8.

cathode is so high that the discharge will hardly pass at all.

I have here another tube shown in elevation and plan in Figs. 7 and 8, fitted with four cathodes of 0.5 inch, 0.75 inch, 1 inch, and 1.125 inch diameter respectively. They all have the same radius of curvature, i. e., 0.75 inch, and

all focus upon the same point on the anticathode, which is mounted upon a spindle, so that it can be turned round so as to face any one of them. With this tube, as with the last shown, it is found that the larger the cathode the less penetrative, and the smaller the cathode the more penetrative are the rays produced. There appears to be no advantage in employing extra large cathodes, even when the exhaustion is made to suit them. Experiments with various sizes, from 2 5 inches diameter down to 0.125 inch diameter, go to show that even with the full power of a 10-inch induction coil with mercury break, there is no advantage in making the cathodes more than 1.125 inch diameter. For use with a 10-inch coil they should not be smaller than about 0.375 inch diameter, as, if less than this, they are

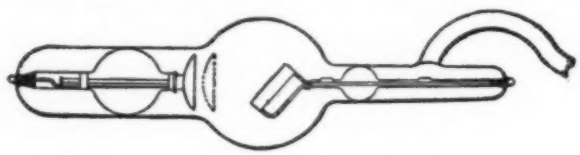


FIG. 9.

apt to become overheated, and their surface and form destroyed. For use with 6-inch and smaller coils, very small cathodes, even down to 0.125 inch diameter, will work very well, and will not require such high exhaustion as larger ones. Small cathodes should, in proportion, have a less focal length than large ones for the best results. Probably, a good average size for ordinary work is about 1.125 inch diameter, and 0.75 inch radius of curvature. It is important for the best work that the surface should be well polished, and to be of quite even curvature.

Another simple and, in my opinion, altogether superior form of adjustable tube, which has the advantage of a fixed point of origin for the x-rays, and which has a great range of adjustment, depends for its action upon the fact that the resistance of the tube and the penetrative value of the x-rays that it generates can be greatly varied by altering the radius of the annular space between the edge of the cathode and the glass of the containing bulb. In this tube (Fig. 9) the anticathode is fixed, but the cathode is mounted upon a steel rod, held in guides, so that by gently tapping the tube the cathode can be moved to a small extent—say, about one-half an inch—in and out of an annex, blown on one side of the glass bulb. The shape of the walls of this annex are such that when the cathode is at one end of its travel, and as far as it can get from the anticathode, the edge of the cathode is very near the glass all round; while as the cathode is moved nearer to the anticathode the annular space between the cathode edge and the glass becomes larger and larger, until at the other end of the travel the cathode emerges from the annex into the bulb itself. With a tube of this construction, the greater or less proximity of the glass to the cathode is found to have a much larger effect in increasing or decreasing the resistance of the tube and the penetrative value of the x-rays than the contrary result that would be occasioned by the alteration in the distance between cathode and anticathode. A travel of one-half of an inch is sufficient to alter the x-rays from the highest to the lowest penetrative value, and between the limits of travel any desired degree of penetrative value is immediately obtained. The adjustable tube just shown was made in my laboratory, but here are two others on the same principle, made respectively by Messrs. W. Watson & Sons and Mr. Cossor, who have kindly lent them to me for exhibition.

In conclusion, I should like to lay stress upon the great importance of good

and accurate workmanship in the making of x-ray tubes if the best results are to be obtained. In no instrument is work of the cheap and nasty description more to be deprecated. Bulbs should be of uniform thickness, and as thin as will bear the atmospheric pressure. Cathode and anticathode should be placed axially so as to produce accurate focussing, and so that they are symmetrical with the glass. The platinum leading-in wires should not be too small, or by becoming overheated they may crack the glass. The cathode and anticathode should be substantially supported so that they can not become displaced. The cathode should not merely be roughly stamped out of sheet metal, but should be turned up and polished on a lathe to a true spherical surface. The terminals should be substantial and a long distance apart so as to preclude sparking between them.

As the application of considerable electric power is found in practice to give the best results, the anticathode should be of sufficient mass not to readily become overheated or deformed. The exhaustion should be most carefully carried out, till as far as possible a permanent degree of vacuum is obtained. Even if tubes made in this way cost more than others, they will give much superior results. They will also prove much more durable, and will in many cases stand being re-exhausted many times. Finally, if eventually the glass is cracked or broken, or becomes too much blackened, the cathode and anticathode will serve again to make another tube.

I trust that I have not wearied you with too much detail, but it is upon detail chiefly that success depends—at any rate, so far as x-ray tubes are concerned—and, after all, of all the apparatus that the practical user of Roentgen rays employs, the tube is the most important, and perhaps I may say also, the least generally understood.

I must mention, in conclusion, how much I am indebted to the untiring assistance of Mr. J. C. M. Stanton and Mr. H. Tyson Wolff, who have made and exhausted all my experimental tubes, and without whose willing aid I do not suppose I should ever have attacked these very difficult problems.

The cuts reproduced in this article were kindly furnished by the *Electrical Engineer*, N. Y. City, for use in THE AMERICAN X-RAY JOURNAL.

DEFLECTION OF THE MAGNETIC NEEDLE IN RUSSIA. *Electricity.*—The result of the investigations made by a French savant and Russian scientist into the extraordinary deflection of the magnetic needle over an immense area of Central Russia show that the greatest aberrations are found in the province of Kursk, the capital town of which is some 600 miles almost due south of Moscow. In the northern part of the province, near Tim, the needle deflects 20 degs.; further south, in the district of Staroi Oskol, up to 30 degs.; while in the southeast of the province, about 150 miles south of Tim, the deflection is over 96 degs., the needle standing almost perpendicular and pointing east and west, instead of north and south. A number of new railway lines are in process of building over this part of the country, and it will be most interesting to railway engineers, says a telegram, to follow the probable effects of this magnetic force on the durability of steel rails, which, in places not specially magnetic, are known to last much longer when laid north and south than when they run in any other direction, the line of most wear and tear from magnetization being, of course, due east and west.

[It has been suggested that since the cathode rays are deflected by the magnet the radiance of a Crookes tube is impaired or improved according to its axial position to the poles of the earth.]

THE PRODUCTION OF X-RAYS OF DIFFERENT PENETRATIVE VALUES.

BY A. A. C. SWINTON.

As is well known, if the x-rays coming from an ordinary Crookes tube of the Jackson focus type be observed with a fluorescent screen during the process of exhaustion, the penetrative value of the rays is found to change as the exhaustion proceeds.

First of all, at less than a certain degree of vacuum no x-rays are produced. Next, as the vacuum is increased, x-rays commence to show themselves, but of a quality that will do little more than penetrate the backing of the screen. As the vacuum is further increased the rays become more penetrative and show the shadow of the bones in the hands. As exhaustion proceeds further, a point is reached when the flesh of the hand seems to be almost completely transparent, while the bones are almost entirely opaque. At higher vacua than this, the bones becoming more and more transparent, the contrast between bone and flesh becomes less and less, t il l at length, at the very highest vacuum at which the discharge will pass, the bones scarcely show at all, owing to their having become nearly as transparent as the flesh, while the whole hand throws but a very faint shadow on the screen.

Similarly, it is found that at any given degree of vacuum the penetrative value of the x-rays is increased by increasing the power of the Ruhmkorff coil, and thereby increasing the difference of the electrical potential between the cathode and the anode portions of the tube, as measured by the length of the alternative spark in air.

Again, similar results are obtained without alteration to the vacuum or to the power of the Ruhmkorff coil by varying the resistance of the tube by means of a magnetic field.

In this case the gradual strengthening of the magnetic field produces a gradual decrease in the resistance of the tube, and of the difference of the electrical potential between the cathode and anode, and, at the same time, causes a gradual diminution of the penetrative value of the x-rays.

I have further found that it is possible to vary the penetrative value of the x-rays produced in a focus tube by simply altering the distance between the cathode and the anti-cathode.

Upon the anti-cathode being approached to the cathode, the x-rays immediately became of a more penetrative value, just as though the vacuum had been increased, while at the same time the potential difference, as measured by the alternative spark, was found to have risen. Again, when the anti-cathode was moved in the opposite direction, and placed at a greater distance from the cathode, the potential difference fell, and the x-rays became less penetrative, and similar to those produced at a lower vacuum. In this way, without varying the vacuum, the penetrative value of the x-rays could *be* increased or decreased as desired within the limits of the focus on the one hand and the travel of the anti-cathode on the other.

Again, I have found that the penetrative value of the x-rays can be altered by employing cathodes of different diameters.

Throughout the experiments it was further found that the potential difference, as measured by the alternative spark in air, was much greater when the small cathode was in use than with the larger cathode.

The penetrative value of the x-rays produced by any given tube appears, therefore, to be dependent upon several conditions.

1. The penetrative value is higher for a high vacuum than for a low vacuum.
2. It is higher when the electrical

power applied is great, than when it is small.

3. It is higher when the resistance of the tube is great than when this resistance is reduced by magnetic means.

4. It is higher when the distance between the cathode and anti-cathode is small than when the distance is great.

5. It is higher when the cathode itself is small than when it is large.

6. It is higher when, as a consequence of one or more of the above, the potential difference between the cathode and anode portion of the tube, and consequently the electrical excitation of the cathode is great, than when it is small.

On the assumption that the cathode rays consist of negatively charged molecules that are repelled from the similarly electrified cathode with an initial velocity that depends upon the degree of electrical excitation of the cathode, the above conditions are those that would conduce to a high average velocity of the molecules at the moment at which they strike upon the anti-cathode, and, at the same time, to a high average difference of potential between the traveling molecules and the anti-cathode at the moment of impact.

At high exhaustion, not only is the electrical excitation more, and the initial velocity of the molecules consequently greater, but, owing to the smaller number of collisions with the other molecules of residual gas in the tube, the average velocity of the molecules and the amount of their negative charge have suffered less diminution by the time they reach the anti-cathode than in the case of lower exhaustions.

Similarly, when more electrical power is employed, the electrical excitation and the initial velocity of the molecules is increased, while the employment of a magnetic field reduces the resistance and the electrical excitation, and consequently reduces the initial velocity and negative charge of the molecules.

Again, when the anti-cathode is near to the cathode, the moving molecules having a less distance to travel before they reach the anti-cathode, have by that time lost less of their initial velocity and charge by collisions than when the anti-cathode and cathode are further apart.

And, lastly, not only does a small cathode become charged to a higher electrical potential than a large one, and consequently impart a higher initial velocity and charge to the molecules, but with a small cathode the traveling molecules are more compactly arranged than with a large cathode, and consequently are not likely to make so many collisions and lose so much in velocity or electrical charge during their transit.

It would, therefore, appear that, whatever the precise cause, the penetrative value of the x-rays, produced under any given set of conditions, is dependent upon the average velocity of the molecules and the difference of potential between them and the anti-cathode at the moment of impact, being higher the higher the velocity and the greater the potential difference.

Further, since the excitation of the cathode is not uniform, but varying, so that different molecules have different initial velocities and charges imparted to them, and since some of the molecules will make fewer collisions than others, and some molecules will thus strike the anti-cathode at higher velocities and in a more highly charged state than others, the same hypothesis will account for x-rays being more or less heterogeneous under all conditions.

Finally, it appears that the penetrative value, as distinct from the quantity of x-rays, is independent of the material of which the anti-cathode surface is made. Experiments with a tube in which the anti-cathode was made partly of platinum and partly of aluminum, and so arranged that, by inclining the tube, the anti-cathode could be moved, and either

the platinum or the aluminum part could be brought into use, show that, even with metals having such very dissimilar atomic weights, the penetrative value of the x-rays produced was the same, though the quantity of the rays, as measured by photographic action or by the brightness of a screen of barium platinocyanide, was distinctly greater with the platinum. Further experiments with other tubes fitted with anti-cathode of aluminum, iron, copper, silver, and platinum, confirm these results. The metals of high atomic weight form the most efficient anti-cathodes, and give a larger quantity of x-rays, though the difference is not so great as might, perhaps, be expected. All, however, appear to give x-rays of the same penetrative value under similar conditions.—*Electricity.*

THE X-RAYS IN THE DISCOVERY OF GALL STONES.—Buxbaum (Carlsbad) recommends the use of photography in searching for gall stones. The patient is placed upon his face with the photographic plate under the abdomen and the tube just over him. In this way clear-cut pictures of the gall stones in the gall bladder may be obtained. The possibility of making these discoveries is of great value in medicine and opens up another field of usefulness for the x-rays.—*Revue med. de therapeut.*, No. 2, 1898. *Journal of Electro-Therapeutics*, May, 1898.

ANATOMICO-SURGICAL RESEARCHES BY MEANS OF RADIOGRAPHY. *Paul Reynier and Jules Glover.*—Most interesting experiments upon radiography of the osseous cavities of the face and cranium, the venous sinuses of the duramater and their relation to the external wall, etc. For a full comprehension of the subject the reader is referred to an illustrated article in the *Archives Internationales de Laryngologie*, November-December, 1897. *Journal of Eye, Ear and Throat Diseases*, April, 1898.

TESTING GOLD QUARTZ BY THE ROENTGEN RAYS.—An ingenious application of the Roentgen rays has recently been made, viz., to ascertain the presence of gold particles in quartz. The particles of gold in a paying gold quartz are often so finely divided as to be invisible to the naked eye. Since gold is more opaque to the Roentgen rays than quartz, it is natural to suppose that some indication of the presence of gold in quartz would be given on the screen or the photographic plate when the quartz is traversed by the Roentgen rays. A physician in Los Angeles, California, is reported on accidentally photographing a lump of gold quartz to have found on the shadow of the outline of the quartz a number of very dark points. These points were due to the presence of particles of gold in the quartz. It is possible, therefore, to detect the presence of gold in quartz by the presence of Roentgen rays, and it may sometimes be convenient in the laboratory, but it is not to be expected that the gold prospector will add a battery, an induction coil, and vacuum tubes to his kit.—*Electrical Review*, London, England, May 13, 1898.

A full account of this discovery can be found in THE AMERICAN X-RAY JOURNAL, Oct. issue, 1897. The discovery was made by Dr. Yoakum, of Los Angeles, Cal.

SEOKOLOFF, of St. Petersburg, reports four cases of acute articular rheumatism in children in whom marked improvement took place after the use of the Roentgen rays. The child was placed from fifty to sixty cm. from the tube, and the time of exposure was sixteen to twenty minutes. In one girl of nine years the pain and swelling of the joints, which were very great, disappeared after two treatments, while one girl of fourteen recovered after the first seance.—*La Rev. Med.*, Jan. 19, 1898.

ACNE TREATED BY ELECTROLYSIS AND THE X-RAYS.*

BY MADAME LE DR. POKITONOFF, OF PARIS.

I propose to submit to you some results obtained in the treatment of obstinate acne by means of the x-ray.

I hope that it may be of interest to women, and young girls, in particular, since it is these cases that I most desire to reach with the aid of the latest scientific discoveries.

Nearly every practitioner recalls cases of acne impossible to cure, in spite of medicaments and rigid diet.

I have tried to treat and alleviate those cases which are beyond the reach of local applications. For years I myself was thus afflicted, and finally I concluded to try massage and electricity.

When my patient is a young girl who has no internal lesions, but whose functions have rather lost tone, and when the forehead above all is most affected, I touch each pimple with an electrode, and I follow this up with a twenty minutes' massage.

In such a case numerous treatments are required—but a series of from twenty to thirty affords much relief.

Notwithstanding the presence of spores and bacilli, which belong to this affection, one must observe that weak tissues about the sebaceous glands is a favorable condition for the development of bacilli, which must be considered as a secondary cause; the first one being the weakened condition of the tissue, which should first be attacked—and here is where massage has a beneficent action.

But I can not recommend this in the case of those enjoying good constitutions, and whose functions are normally active. I tried faradism instead, which acts most favorably on muscular contractions, and it possesses as well the merit of causing an amelioration in those conditions where there is much congestion.

For in many cases of acne the local congestion is the first thing to be combatted, I have tried electro-massage, *i. e.*, massage and electricity combined, which is an economy of time.

With certain women acne has a bad moral effect, as they are constantly worrying about it. For this reason, having failed in my other methods, I decided to try the x-ray.

The following is an account of one of three cases:

Miss M., twenty-three years old, good constitution, family history good—parents living—lived always in country; menstruated at fourteen, irregular, scant, but without pain; had measles and scarlatina; at seventeen had a gastric disturbance, with cramps and colic, but was not confined to her bed.

She had pimples before her menstruation, at the age of ten—did not treat them, believing in their disappearance at puberty. As, on the contrary, they increased, she consulted a physician.

At fifteen she followed a special diet, took various alteratives, used many local applications, but in vain; at twenty-three she came to me and announced that she wished to marry in a year, and begged me to remove the deformity.

Having touched each pimple separately with the electrolytic needle, we commenced the electro-massage.

The treatments lasted about thirty minutes, after which I covered each pimple that had been treated with a small piece of surgical plaster. The following five treatments were each of them from thirty to thirty-five minutes, on alternate days, making ten treatments in fifteen days; after which she felt so much better that she decided to return to the country.

Indeed, each pimple became smaller by this method, and the redness gradually disappeared. But, on the other

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hand, the patches on the cheeks appared to grow.

Later we had three new series of treatments, and after seven months although better she was not cured. As the time of her marriage approached it was necessary to do *something*, as her mental distress was great, so I sent her to my excellent confrere, Dr. Gautier, for electric baths—she slept and ate better, but the patches and pimples remained. Finally we decided to submit her to the influence of the x-ray, which after twelve treatments bleached the red blotches without accident.

Dr. Gautier gives the details of the treatment as follows:

We know that the x-rays have caused erythema and deep burns—these accidents are due to lack of care; not only is the x-ray without danger if employed properly, but it may be of great service in dermatology. The treatment should be applied as follows: 1. Daily treatment. 2. Duration, five or six minutes. 3. Crookes tube, medium size, excited by a coil which takes four amperes at eighteen or twenty volts, tube enveloped in a black cloth. One must finally protect the eye-brows, eye-lashes, and hair by means of a plate of lead; the lead is flexible, and may be molded at will to the shape of the skull.

The tube should be thirty centimeters from the face, and first one side and then the other of the face should be treated. A result begins to show itself after six treatments; the skin peels, the pimples become less red, and the glands are less apparent. It is right to inquire how the x-ray acts. This is, by a decongesting atrophic action, and probably also by a microbicidal action. This atrophic action affects also the follicles, for the hairs fall out, to grow again finer. The nails become brittle. These accidents have not occurred with us, for we have kept the tube thirty centimeters away from the patient; and we know that at this distance the electric waves lose their force. And according to the last researches of Dr. Balthazard, these electric waves are responsible for the accident, and not the x-rays themselves. Besides, these waves lose their power when the tube is wrapped in black cloth.

Imperial Granum

Is a prepared food that makes friends wherever its merits become known. The writer has been familiar with it for years, and takes pleasure in relating the following clinical test of its merits:—"The patient, reduced by disease and from the effect of the anodynes necessarily given to alleviate her sufferings, developed malignant cholera-morbus, and for days lay in an almost unconscious condition. As a last resort she was taken to a Boston hospital where the physicians began administering IMPERIAL GRANUM, prepared as directed for acute cases, in very small quantities. After several trials it was retained, and the strength and quantity was slowly increased. After four weeks' treatment, taking IMPERIAL GRANUM only for nourishment, she was discharged from the hospital, and a few weeks later endured a severe surgical operation from which she completely recovered, and today seems in perfect health."

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"This preparation commends itself to the medical profession for the following reasons:

"1. Because it is the result of scientific experimentation by scientific men.

"2. Because the tests as to its efficiency as a germicide were conducted in a scientific manner by scientific chemists and bacteriologists.

"3. Because the preparation was introduced to the medical profession in a proper, ethical manner, and without exaggerated claims and unprofessional hornblowing in the journals and newspapers.

"A. C. BERNARS, A.M., M.D., M.R.C.S."